

1. A prosthesis for surgical implantation to replace a segment of a blood vessel, the prosthesis comprising:

5 a first tube of biologically compatible material having an exterior surface, a membrane of polymer material positioned about the exterior surface of the first tube, and

10 at least one support structure wound along a winding axis about the membrane to form axially spaced-apart ridges on the membrane that enable the material to substantially close a hole that is created when the material is punctured by a needle or 15 cannula, the membrane having a microstructure of nodes interconnected by fibrils effective to facilitate bonding of the support structure to the membrane and inhibit delamination of the support structure from the membrane.

2. The prosthesis of claim 1, wherein the support structure includes a metal wire.

15 3. The prosthesis of claim 1 further comprising an outer polymer membrane placed over the support structure, the membrane, and the first tube, the outer polymer membrane bonding to the membrane and enclosing the ridges.

20 4. The prosthesis of claim 1, wherein the ridges are spaced apart a distance effective to direct a needle to a puncture site at an angle that inhibits needle plowing and hole enlarging, the spaced apart distance being approximately less than or equal to 1.5 times the outer diameter of the needle.

25 5. The prosthesis of claim 1, wherein the first tube, the membrane, and the support structure are coalesced by heat.

30 6. The prosthesis of claim 1, wherein substantially all the nodes forming the microstructure of the membrane are oriented at angle relative to the winding axis of the support structure, the angle being other than 0° relative to the winding axis.

7. The prosthesis of claim 1, wherein substantially all the nodes forming the microstructure of the membrane are oriented in a direction substantially perpendicular to the winding axis of the support structure.

5 8. The prosthesis of claim 1, wherein the first tube is constructed from a polymer material having a microstructure of nodes interconnected by fibrils, the nodes forming the membrane being smaller than the nodes forming the first tube.

9. The prosthesis of claim 8, wherein the nodes forming the membrane are at least 10% smaller than the nodes forming the first tube.

10. A prosthesis for surgical implantation to replace a segment of a blood vessel, the prosthesis comprising:

15 a first tube of biologically compatible material having an exterior surface, a membrane of polymer material positioned about the exterior surface of the first tube, and a plurality of spaced-apart rings placed about the membrane to form axially spaced-apart ridges on the membrane that enable the material to substantially close a hole that is created when the material is punctured by a needle or cannula, the membrane 20 having a microstructure of nodes interconnected by fibrils effective to facilitate bonding of the rings to the membrane and inhibit delamination of the rings from the membrane.

11. A prosthesis comprising:

25 an inner tube of polymer material having an exterior surface, a membrane of polymer material positioned about the exterior surface of the inner tube, and at least one support structure wound along a winding axis about the membrane to form axially spaced-apart ridges on the membrane that enable the material to substantially close a hole that is created when the material is punctured by a needle or 30 cannula, the membrane having a microstructure of nodes interconnected by fibrils, the nodes being oriented at angle relative to the winding axis effective to facilitate bonding of the support structure to the membrane.

TOP SECRET//SCI

12. A method of making a prosthesis, the method comprising:  
    providing a first tube of biologically compatible material having an exterior  
    surface,  
5        positioning a membrane of polymer material about the exterior surface of the  
    first tube, and  
        winding at least one support structure along a winding axis about the membrane  
        to form axially spaced-apart ridges on the exterior surface that enable the material to  
        substantially close a hole that is created when the material is punctured by a needle or  
10      cannula and the ridges being apart a distance effective to direct a needle to a puncture  
        site at an angle that inhibits needle plowing and hole enlarging, the spaced apart distance  
        being less than 1.5 times the outer diameter of the needle, the membrane having a  
        microstructure of nodes interconnected by fibrils effective to facilitate bonding of the  
        support structure to the membrane and inhibit delamination of the support structure from  
15      the membrane.

100-70-1125660